



Fire Protection Technologies, Inc.

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September 20, 2004

Mr. Sunil Weerakkady
Head of the Fire Protection Group
Nuclear Regulatory Commission (NRC) CWFN
1155 Rockville Pike
Rockville, MD 20852

Dear Mr. Weerakkady:

The fire protection of all nuclear power plants could be significantly improved by using a firestopping method developed by Fire Protection Technologies, Inc., that prevents the rapid spread of fire from one compartment to another, especially in the event of a terrorist attack. This simple and very safe method involves the external encapsulation of penetrations in walls and floors regardless of the type of firestop material currently in place. It has been approved by UL[®] and Factory Mutual Insurance (FM Global). It is described in article titled, "New Method of Using Flammadur E473 as an External Seal", which is available on request via e-mail or hardcopy.

We have heard that NRC has requested that all Nuclear Power Plants provide a list by October 29 of possible improvements that would enhance their security. Also, we hope very much that funds will be available from Homeland Security to pay for some of these improvements. We would appreciate your consideration and evaluation of our firestopping method.

We have attempted to send e-mails to the personnel involved with fire protection at the nuclear plants but have been unsuccessful in many cases. We are requesting information on how to contact the appropriate personnel at all NPP or that you notify them to contact us. For your information we have attached a copy of the flier that we would like to be distributed.

Sincerely yours,

Dr. Adolf R. Hochstim
Technical Director, FPT Flammadur, a division of
Fire Protection Technologies, Inc".

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addressee
to e-POs



FPT Flammadur, a division of Fire Protection Technologies, Inc.

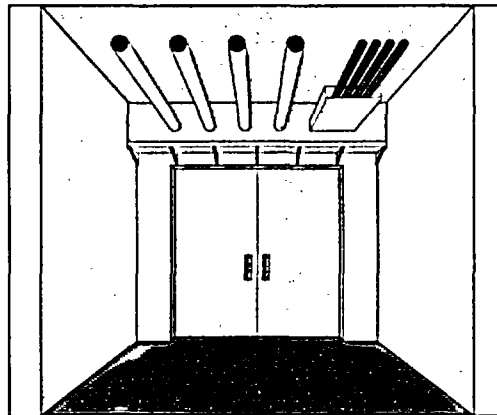
New Method of Retrofitting Firestop Systems in Nuclear Power Plants and DOE Labs

For over 30 years, Flammadur materials have been used successfully in many of nuclear power plants in Europe and in numerous industrial facilities and high rise buildings around the world.

Now, using Flammadur materials, Fire Protection Technologies, Inc. (FPT), has developed new and unique systems for retrofitting firestops (patent pending), which leave the existing, old seals, which can with age shrink, deteriorate and become non-performing, in place. The need for such systems is especially urgent now because of the potential vulnerability of facilities to rapid fire spread from a large fire cause by an external source.

This new method of retrofitting applies to firestops in fire rated concrete walls and floors with

- **cables**
- **cables in cable trays**
- **cables in conduits**
- **metal pipes**
- **busways**
- **ducts**



These new systems are cost effective since they

- **eliminate the need to remove low level radioactive non-performing firestop seals**
- **avoid possible cable damage during old seal removal**
- **avoid future seal replacement (the new external seals will last the lifetime of the building)**

The penetrations are encapsulated on the outside with a mortar, Flammadur® E473 which is

- **long lasting**
- **inorganic**
- **cementitious**
- **heat-absorbing**
- **resistant to the gamma radiation**
- **non-toxic, and contains no asbestos or no halogens**
- **withstands floods and high pressure water (such as from a broken steam pipe)**

These new systems have been thoroughly tested at Underwriters Laboratories, Inc. (UL[®]), witnessed and approved by Factory Mutual Insurance (FM Global) and have attained the following ratings:

| Penetrant | Fire (F) rating | Temperature-time (T) rating |
|----------------------|-----------------|-----------------------------|
| Power/control cables | 3 hrs | 3 hrs |
| Metallic pipes | 3 hrs | 2 hrs |

For additional detailed information, please see the attachments:

- "New Method of Using Flammadur E473 as an External Seal"
- "Three Hours Fire Prevention Using Flammadur Tested Firestop Systems for Nuclear Power Plants and Other High Security Buildings"

or go to our website: www.flammadur.com or contact Dr. Adolf R. Hochstim, FPT Technical Director, at e-mail: ahochstim@earthlink.net or phone: Tel/fax 626-795-9109, or 800-FLAMMADur

NEW METHODS OF USING FLAMMADUR® E473 AS AN EXTERNAL FIRE SEAL FOR:

- **ENCAPSULATING PENETRATIONS WITH OLD
NON PERFORMING SEALS, WITHOUT THEIR
REMOVAL AND NEW HIGHER F AND T RATINGS**
- **SEALING PENETRATIONS WITH TOO SMALL
ANNULAR SPACES**

Patent pending



| | |
|---|--|
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1. New Method of External Fireproofing

The new method (patent pending) utilizes cementitious Flammadur® E473 material, manufactured by AIK Flammadur Brandschutz GmbH in Germany and soon to be made in New Mexico. The E473 is used on the outside of walls and floors, around the existing penetrants (pipes, conduits, cable trays, busways, cables). It has a cylindrical form around pipes, conduits and a rectangular form around cable trays and busways. This external mass extends about 6 inches (152mm) from the surface of a wall or floor, on both sides of a wall or floor, and about 4 inches (102mm) from an outside surface of penetrants.

The liquid E473 is poured between pipes, between conduits and the outside steel sleeve, or between the sides of the cable tray and steel or wooden or other damming frame. The E473 is also poured between the cables and between cables and the sides of the cable tray.

The liquid E473 expands slightly on curing, making a tight fit, so in case of a fire, this external seal will not permit passage of flames, smoke or toxic fumes through the penetration.

If movement of pipes, etc., is required, then each pipe can be covered with a thin layer of foil or fiberglass, e.g., with fiberglass mat Flammadur A153, before the E473 is poured.

2. Test Results

Certified by Underwriters Laboratories (UL®) and approved by Factory Mutual. The test was conducted at UL on September 25, 2001 at UL in Northbrook, Ill., and witnessed by a representative from Factory Mutual Research Corporation. Flammadur® E473 was placed only on the outside of the penetrants, with no material inside the floor, with the exception of 1 inch (25mm) of a layer of mineral wool on the top of the floor for damming purpose. The test results are applicable if there is a non-performing seal inside the floor or no seal at all. The thickness of the seal, from the outside of the steel sleeve was 4 inches (102 mm), and the height of the seal from the surface of the floor was 6 inches (152 mm) and the same on the bottom of the floor. The floor assembly was tested for 3 hours in the UL furnace, up to a temperature of 1925 °F (1052 °C) and then subjected to a water hose stream of 30 psi (200kPa). The assembly passed the tests and the resulting fire (F) and temperature (T) rating are given in the next tables.

The results are applicable to concrete floors and walls, for a thickness of concrete of 4.5 inches (114 mm), or thicker. The stainless steel sleeve, 1/64 inch (0.39 mm) thick, was placed on the top and bottom of the floor surrounding the pipes and cable trays.

RESULTS OF TESTS CONDUCTED AT UNDERWRITERS LABORATORIES AND WITNESSED BY FACTORY MUTUAL

UL CERTIFIED

FACTORY MUTUAL APPROVED

Concrete Floor or Wall, 4.5 inch (114 mm), or greater

Outside Block of Flammadur® E473 – on Both Sides of the Wall or Floor

Depth of Flammadur® E473 Seal: 6 inch (152 mm) on each side of the wall or floor

CABLE TRAY (24 inch x 4 inch (610 x 102 mm))

UL System C-AJ-4068, Factory Mutual Firestop Design System 441 (3 hours)

| Type of Cable | F(Fire) Rating (hours) | T (temperature) Rating (hours) |
|----------------------------|------------------------------|--------------------------------------|
| 1/C 350 kcmil power cables | 3 | 1 |
| 7/C 12 AWG control cable | 3 | 3 |

METALLIC PIPES AND CONDUITS

UL System C-AJ1434, Factory Mutual Firestop Design System 442 (3 hours)

| Pipe | Maximum Outside Diameter inch (mm) | Minimum Pipe's Wall Thickness inch (mm) | F(Fire) Rating (hours) | T (temperature) Rating F (hours) |
|---------------|---|--|------------------------------|--|
| steel pipe* | 24(610) | 0.250(6.4) | 3 | 0.75 |
| steel pipe | 6.625(168) | 0.134(3.4) | 3 | 2 |
| steel conduit | 6.625(168) | 0.134(3.4) | 3 | 2 |
| copper pipe | 6.625(168) | 0.250(6.4) | 3 | 1 |
| copper tubing | 6.125(156) | 0.140(3.6) | 3 | 1 |
| copper pipe | 2.375(60) | 0.109(2.8) | 3 | 2 |
| copper tubing | 2.125(54) | 0.060(1.5) | 3 | 2 |

*UL System C-AJ-1504

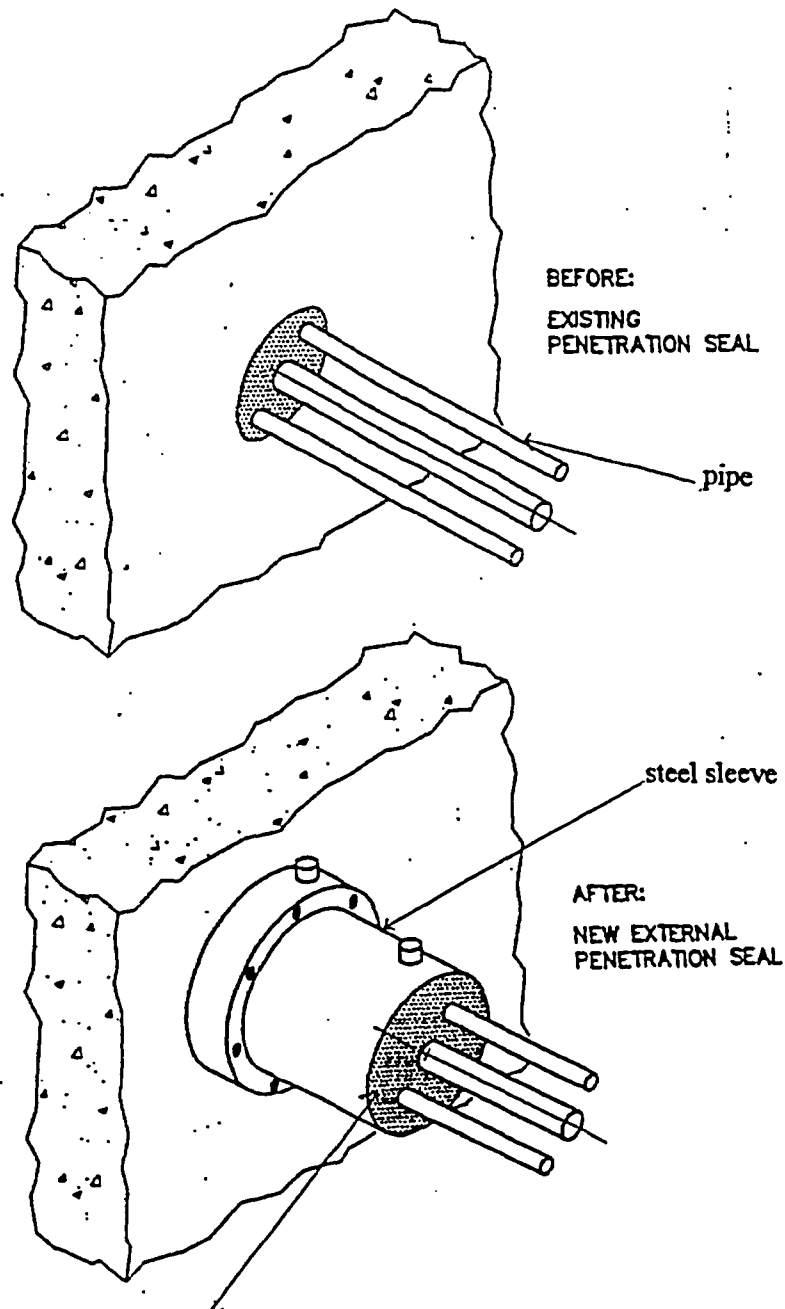
3. New Flammadur E473 External Seal

The concept of using heat absorbing Flammadur®E473 externally to an existing firestop seal should be applicable to other penetrations with other combinations of metallic pipes, conduits, and cable trays, without any further tests. No maintenance of new external seals will be needed. Flammadur®E473 is long lasting, with an expected life-time of over 50 years. Old nuclear power plants can save money on the cost of inspections by installing external firestops, reducing the cost of insurance and the cost of getting certification for an extended life-time of nuclear power plants.

Retrofitting for adding pipe or cable:

Flammadur®E473 can be easily drilled.

It is resistant to high water pressure from broken steam pipes, from flood, and because of the high shearing strength, it is not easily displaced by minor explosions, pressure overload from tornados, etc.

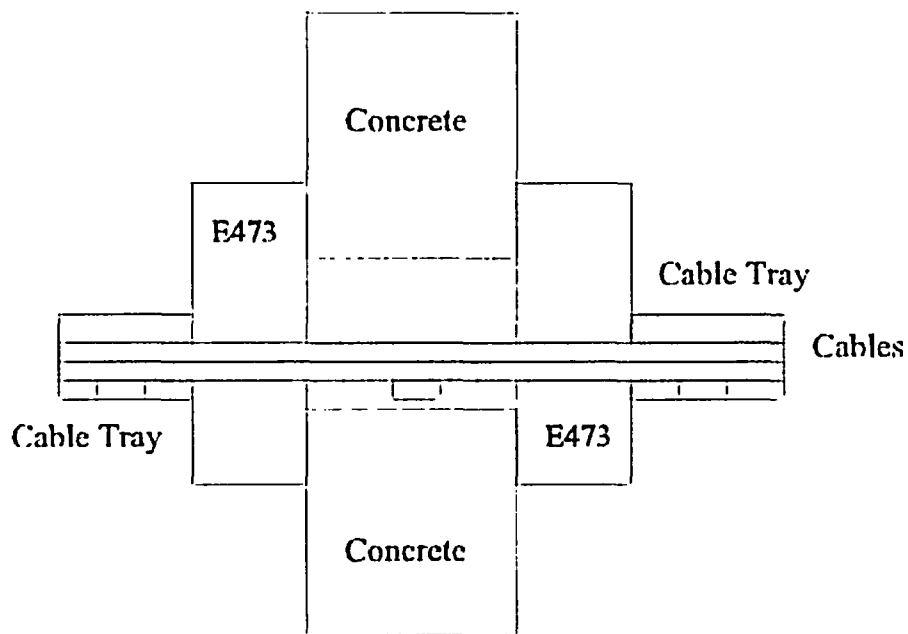


New external only seal (Flammadur® E473)

Figure 1 Cables without Cable Tray, with a Non-Performing fire seal, Fitted with a New Flammadur® E473 External Seal

Cable Tray through Wall or Floor

Side View

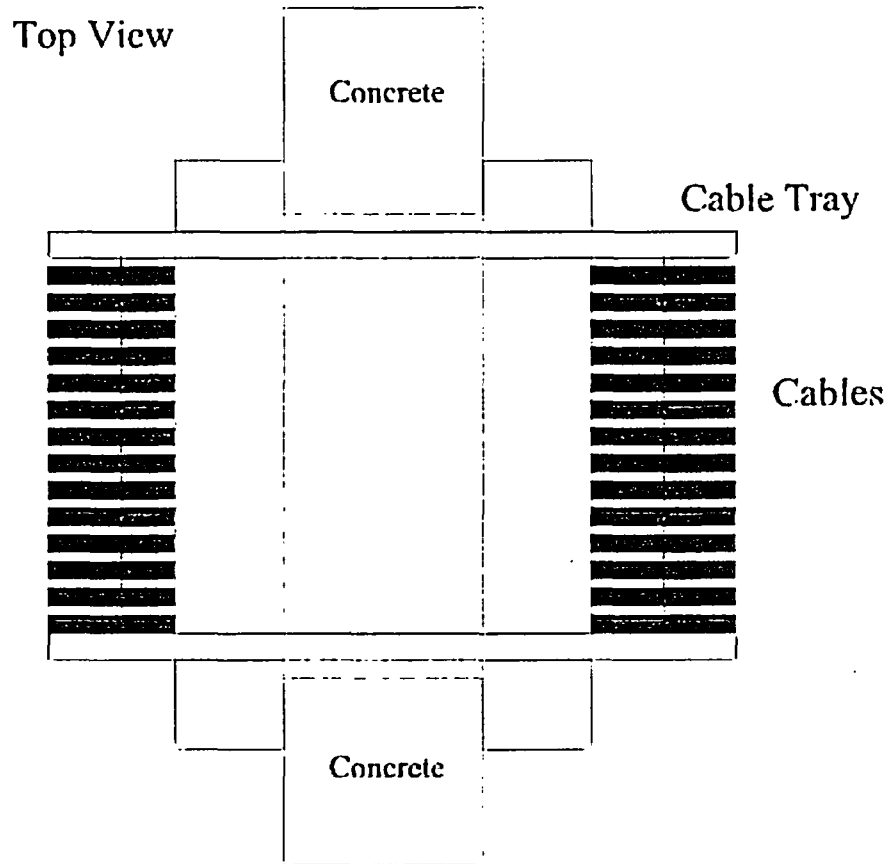


Flammadur E473 inside Cable Tray

(Cross-section through cables in penetration)

Figure 2 Side cross-section of a Cable Tray, with a Non-performing Fire Seal, Fitted with a New External Fire Seal

Cable Tray through Wall or Floor



Flammadur E473 inside Cable Tray
(Cross-section above cables in penetration)

Figure 3 Top cross-section of a Cable Tray, with a Non-performing Fire Seal, Fitted with a New External Fire Seal

Steps in the Installation of an External Seal of Flammadur E473

Step 1: (see Figure 4)

All concrete and metal surfaces, to be in contact with the E473 mortar, must be free of all paint and other foreign substances to insure bonding with the E473 mortar.

Step 2: (see Figure 5)

A containment structure must be constructed to hold the E473 in place until it has set (hardens). Damming may be temporary or permanent depending on the location of installation. For horizontal penetrations (vertical seals), a permanent metal support or shelf is recommended.

Step 3: (see Figure 6)

The containment structure (box) must be attached to the wall (or floor) to keep it in place. Temporary braces can be used. Any opening through which the E473 can escape must be filled or covered, duct tape works well. Openings must be provided through which E473 can be installed. After the E473 has been mixed, installed, set and dried, the temporary damming can be removed.

Figure 4

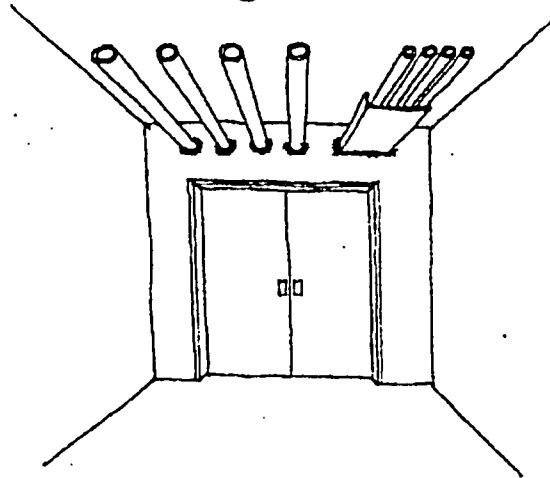


Figure 5

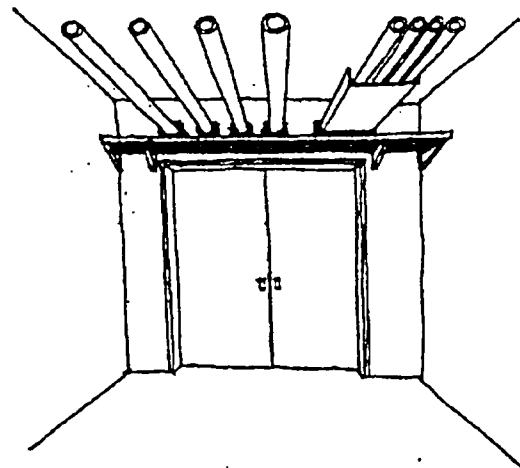
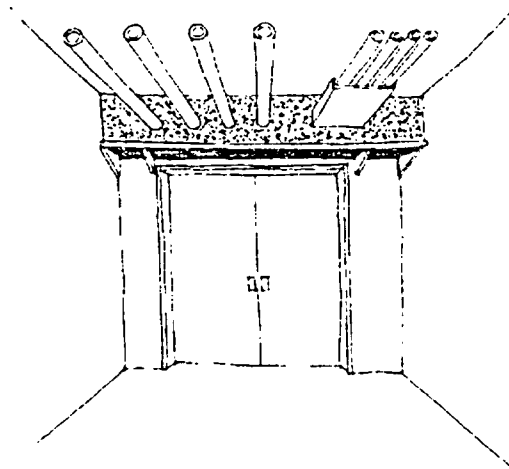


Figure 6



THREE HOURS FIRE PREVENTION USING FLAMMADUR TESTED FIRESTOP SYSTEMS FOR NUCLEAR POWER PLANTS AND OTHER HIGH SECURITY BUILDINGS

Dr. Adolf R. Hochstim, Technical Director
Fire Protection Technologies, Inc
August 24, 2004

I. Fire Protection with Flammadur Firestops in Through Penetrations

Flammadur® E473 was developed by a division of German General Electric (AEG) over 30 years ago and is now manufactured by AIK Flammadur Brandschutz, GmbH in Germany. Fire Protection Technologies Inc (FPT) has an exclusive distribution license throughout the world for Flammadur materials in Nuclear Power Plants.

Systems with Flammadur E473 in penetrations have been used in nuclear power plants in Germany, Belgium and Finland for over 25 years without any problems.

A. Fire (F) Ratings

[In International Standard (ISO): I(Integrity)Rating, in DIN: F]

The concrete walls and floors of nuclear power plants (NPP) and other high security buildings inhibit the spread of fire from one area to another by serving as “fire rated barriers”, normally with a fire rating of 3 hours. If an opening is made in such a barrier to facilitate any passage of penetrants (metallic pipes, cables, metallic conduits with cables inside, cable trays with cables, etc.), then these openings must be sealed around the penetrants using fire tested and approved firestop systems with a fire rating of 3 hours (F=3 hours), thereby, ensuring, that in case of fire, these sealed openings will not pass fire, smoke, and toxic fumes for at least 3 hours.

This 3 hour window allows firemen the time needed to reach the area on fire and to extinguish it. A second team of firemen should check on all adjacent

areas having penetrations in common walls, floors or ceilings (fire barriers) with the area on fire.

In the USA, the building codes require fire tests to be performed according to the specifications of the American Society of Testing Materials (ASTM), ASTM Standard E 814-02, entitled “Fire Tests of Through-Penetrations Firestops” which were incorporated in testing by Underwriters Laboratories, Inc under ANSI/UL 1479 and by other testing laboratories. ASTM Standard E814, entitled “Fire Tests of Through-Penetration Firestops” (incorporated in ANSI/UL 1479 as NFPA 251, ANSI/UL Standard 263. These standards, similar to the International Standard (ISO), specify the oven’s temperature as a function of time, which are within maximum 60°C difference from ISO’s temperatures..

Hose Stream Test [Not required in ISO Standards and in DIN]

In addition, penetration firestop seals must also pass a short duration high pressure water hose stream test to simulate conditions occurring when firemen extinguish a fire by spraying water on walls and floors and to test the integrity of firestop seal. This test is necessary to prove that the penetration firestop seals are not displaced and thus do not pass smoke, fumes and water to the off-fire side.

All Flammadur firestop systems using cementitious Flammadur® E473 passed such fire and hose stream tests at Underwriters Laboratories (UL®) in the USA with F=3 hour ratings, and are also approved by UL® in Canada. Most of these tests were witnessed by Factory Mutual Insurance Corporation (FM Global) and received or are in the process of receiving their written approvals.

B. Time-Temperature (T) Rating

[in International Standards (ISO): R(resistance) rating, in DIN S rating]

In addition to F rating of penetration seal systems, the temperature (T) -time rating is important and, in some cases, may impose more severe time constraints for NPP designers and firemen than the F rating.

After the fire test, the T rating is determined by the testing authorities. It specifies in hours the time that the temperature on the unexposed surface of the wall or floor assembly (“fire barrier”) in the test does not exceed 325°F (181°C) above ambient temperature. This temperature limit on the off-fire side of the wall corresponds to the ignition temperature of cable insulation and the combustion temperature of materials which could have been left in contact with hot pipes, ducts, etc.

Insulation and jackets are available with cables qualified according to tests on vertical tray gas burner, as specified by IEEE 383. In fire tests in furnaces those cables ignite from a few minutes to 3 hours, and have no effect on T ratings, which depends on amount of firestop seal, type of cable with cable insulation and an additional heat absorbing cable coating on off-fire side.

Selected Flammadur firestop systems were tested at UL[®] with F=3 and T=3 hours ratings. The T=3 hours ratings combined with F=3 hour ratings yields the most secure fire protection systems.

Firemen will have up to 3 hours to get to the area on fire, and for extra safety, the second team of firefighters will have up to 3 hours to reach areas adjacent to the fire on the other side of fire barrier.

Please see Tables A and B below for results of tests for various cables (power/ control, power, data, fiber optical) passing through concrete fire barriers.

Higher T ratings were obtained for the same cable, when the cable tray was absent. This is in confirmation with common installation procedure used in NPP, when cable tray stops before fire barrier and begins on the other side, with cables passing through firestop (Flammadur E473) inside the barrier. This method avoids inserting heat inside fire barrier through metallic cable tray. This is of special benefit to the power and control cables.

Metallic pipes, ducts, or busways with various seals are normally rated at T = 0. This is worrisome because with a fire on one side of the wall, the off-fire side becomes very hot in a short time, and therefore, combustible materials inadvertently left nearby could ignite and cables on the other side of the wall or floor can and, most likely, will ignite within minutes. **The best way to prevent such secondary fires is to insulate the metallic penetrants at least inside the fire barrier and seal with Flammadur E473 to provide a T rating of 3 hours** (see Table C). Insulation consisting of only mineral wool or ceramic fibers is sufficient in this case. This method has the additional advantage of permitting, in a simple way, the movement of large pipes.

If systems have T = 1 hour only, the second team of firemen have one hour to reach and extinguish any fire on the off-fire side. A fire protection scheme that depends on a second team of firemen reaching in parallel an area with uncoated cables having a low T rating may be complicated because it requires:

- *rapidly determining the location of one or as many as six (6) adjacent areas with common fire barriers to the area on fire,*
- *establishing which of these adjacent areas have penetrating cables, pipes, ducts, etc. (Development of a pre-determined list of all potential fire areas and their adjacent vulnerable areas may be prudent to do), and*
- *directing in parallel the second fire fighting team to these crucial areas.*

Table A

Flammadur® E473 Systems for Fireproofing Cables in Concrete Barrier

Systems with F=3 hours, and T=3 hours

| CABLES | Cable Jacket Type | UL System No. | F hours | T hours |
|---|--------------------------|----------------------|----------------|----------------|
| Max. No.2 AWG multi-conductor power and control cable; | XLPE insulation with PVC | CBJ 3008 | 3 | 3 |
| Max. No.2 AWG multiple-conductor power and control cable; IN CABLE TRAY | XLPE insulation with PVC | CBJ 4010 | 3 | 3 |
| Max. 7 pair No.12 AWG multi-conductor power and control cable | XLPE insulation with PVC | CBJ 3009 | 3 | 3 |
| Max.7/C No.12 AWG copper conductor power and control cables IN CABLE TRAY with EXTERNAL RETROFIT | XLPE insulation with PVC | CAJ 4068* | 3 | 3 |
| Max.No. 16 AWG shielded twisted pair copper conductor instrumentation cables | XLPE insulation with PVC | CAJ 3046* | 3 | 3 |
| Max.2 pair No.16 AWG shielded data cable | Teflon | CAJ 3028 | 4 | 4 |
| Max. 300 kcmil single copper conductor power cable | XLPE insulation with PVC | CBJ 3008 | 3 | 3 |
| Multiple fiber optical communication cable | PVC | CAJ 3046* | 3 | 3 |

* Factory Mutual Design No. 122,

** Factory Mutual Design No. 441 (3 hrs)

(XLPE =cross-linked polyethylene, PE=polyethylene, and PVC=polyvinyl chloride)

Table B

Flammadur® E473 Systems for Fireproofing Cables

F=3 hours, T=1 and T=1.5 hours

| CABLES | UL System No. | F hours | T hours |
|---|----------------------|--------------------|--------------------|
| Max. 7 pair No.12 AWG multiple copper Conductor power and control cable | CAJ 3046 | 3 | 1** |
| Max. 2 pair No. 16 AWG instrumentation data Cable | | | |
| Max. 300 kcmil single copper conductor power cable IN CABLE TRAY | CBJ 4010 | 3 | 1.5** |
| Max. 350 kcmil single copper conductor power cable IN CABLE TRAY with EXTERNAL RETROFIT* | CAJ 4068 | 3 | 1 |

* Factory Mutual Design System No. 441(3 hrs),

**T=3(in Table A) with more depth of E473

Table C

Flammadur® E473 Systems for Fireproofing Metallic Pipes

F=3 hours, T=0.75, 1, 2 and 3 hours

| PIPES | Maximum Outside Diameter inch(mm) | UL System No. | F hours | T hours |
|---------------------------|-----------------------------------|------------------------|---------|---------|
| Insulated steel pipe | 20(508) | CAJ 5201* | 3 | 2 |
| Insulated steel pipe | 6.625(168) | CAJ 5200*,5202* | 3 | 3 |
| Insulated steel conduit | 6.625(168) | CAJ 5202* | 3 | 3 |
| Insulated copper pipe | 6.625(168) | CAJ 5200* | 3 | 3 |
| Moving pipe & boot** | 20(508) | CAJ1086* ⁺⁺ | 3 | 1 |
| Steel pipe | 6.625(168) | CBJ 1010 | 3 | 1 |
| Steel pipe RETROFIT*** | 24(610) | CAJ 1504 | 3 | 0.75 |
| Steel pipe RETROFIT*** | 6.625(168) | CAJ 1434* ⁺ | 3 | 2 |
| Steel conduit RETROFIT*** | 6.625(168) | CAJ 1434* ⁺ | 3 | 2 |
| Copper pipe RETROFIT*** | 6.625(168) | CAJ 1434* ⁺ | 3 | 1 |
| Copper pipe RETROFIT*** | 2.375(60) | CAJ 1434* ⁺ | 3 | 2 |
| Copper tubing RETROFIT*** | 2.125(54) | CAJ 1434* ⁺ | 3 | 2 |

* Witnessed by Factory Mutual, approval reports in preparation

*⁺ Factory Mutual Design No. 442 (3 hours)

*⁺⁺ Factory Mutual Design No. 125(3 hours)

** Without E473, with ceramic fabric, pasted with thin layer of Flammadur E424

*** With external E473

II. Fire Protection of Cables between Walls and Between Floor

A. In Small Fires

In order to extend the effective **T rating** for cables emerging from fire rated walls or floors, the cables can be covered with a **heat absorbing** protective fire retardant, thereby, extending the time window for reaching and extinguishing fire on cables on the off-fire side.

To obtain a high T ratings, Flammadur cable systems often use a thin (3mm dry) layer of Flammadur[®] E424 heat absorbing (ablating) fire retarding coating within 15 inches (381 mm) of a wall or floor. When used in combination with heat absorbing Flammadur[®] E473 mortar inside the penetration, this keeps the cables cool for up to 3 hours (T=3 hour), depending upon the particular type of cable tested. Applying E424 over additional lengths will further extend the T rating. E424 was exposed to 200 million rads of gamma radiation, equivalent to an average exposure in a NPP over 40 years, with subsequent fire exposure (vertical burn test) at Factory Mutual. Test results were identical to those obtained on material that was not subjected to gamma radiation.

At distances further from the wall or floor, cables are protected **from fire and from igniting the cables and propagating flames along the cables**, by using cables with fire retardant jacket and insulation. Fire retardant insulation and jackets are available with cables qualified according to test on a vertical tray gas burner, based on modified IEEE 383 [accepted by NELPIA(ANI) and by Insulated Cable Engineering Association (ICEA T-29-520) for NPP with upgraded heat input of 63 kW (210,000 BTU/hour), exposed for 20 minutes.]

Additional fire protection can be obtained by coating cables with 1.6 mm (dry) layer of Flammadur[®] A77. This **intumescent and fire retarding cable coating** expands up to 50 times upon exposure to fire, preventing heat and flames from reaching the cables, and is also a fire retardant. A77 was fire tested on a vertical tray at Factory Mutual Insurance Corporation (FM Global), and also for aging, ampacity derating, etc. When a short circuit occurs in electric cable, A77 expands with visible char in the location of the short circuit. Numerous other coats were also tested and approved by Factory Mutual for fire protection for grouped electric cables. A77 was also exposed to 200 million rads of gamma radiation and then was exposed to vertical burn test at Factory Mutual yielding results identical to tests results using unexposed samples.

For cable trays extending over long distances in a large space, one can also use additional **Cable Tray Fire Breaks** to stop a fire from propagating along the cables.

Each fire break consists of a block of Flammadur[®] E473 mortar extending 8 inches (203 mm) along the cable tray and covering the cables up to the top of the tray. The distance between fire breaks should not exceed 20 feet (6.1 m) for horizontal trays and 15 feet (4.6 m) for vertical configurations.

C. Fire Protection of Energized Cables-in In Large Fires

There is a need to fireproof control and power cables which carry an electric current. Simple insulation may not be sufficient, because at normal operating conditions the generated heat will not dissipate, increasing the ampacity derating. One such need is to protect the control cables that carry the signal to shut down the reactor in a fire in a nuclear power plant through possible fire areas.

Currently, fire resistant cables are made for emergency power to fire pumps, fire alarm systems, etc. Such fire resistive cables are tested in a furnace, reaching in 2 hours temperature of 1010 °C . Such tests are performed by Underwriters Laboratories in USA, under UL 2196 “Tests for Fire Resistive Cables”, based on ANSI / NFPA 70”. Cables are energized with AC voltage and small currents of 0.25 to 0.5A, tested in a furnace for up to 2 hours, during which circuit integrity of the cables is demonstrated by illumination of lamp assembly. For example for cables which passed such tests: one cable type was insulated with compressed MgO powder, with solid copper conductors , made in UK by AEI Cables Limited, division of TT Electronics, another example is cable Lifeline, made by Draka USA, with insulation made from ceramified silicone rubber .

D. Redundant Train of Cables

For added fire safety in a NPP, an extra **redundant train of control cables** should be used in order for control room personnel to facilitate a safe shutdown of the plant. Only one set of redundant cables should be allowed to pass through each fire area.

For maximum fire protection, these redundant control/power cables in a cable tray should utilize

- **Flammadur[®] E473 in all penetrations using systems with F and T ratings of 3 hours.**
- **Flammadur[®] E424 cable coating in the near vicinity of fire barriers,**
- **Fire Proof Electric Cables tested to UL 2196 for passing current for 2 hours in a standard fire**

III. Retrofitting Non Performing Seals inside Penetrations without their Removal * (patent pending)

Over several decades, certain penetration seals have failed in nuclear power plants in the United States. In some cases the seal material shrank, in some it deteriorated, and in a few cases the materials even became combustible. In addition to the cost of removing the old seals, the possibility of accidentally cutting the cables in the process of removing the old non-performing seals and replacing with new ones is a concern. Moreover, the old seals may have become slightly radioactive, thereby complicating their removal and storage.

A new method of retrofitting these suspect seals (UL tested, certified and Factory Mutual Approved Systems and patent pending) involves the installation of Flammadur[®] E473 cementitious material on the outside of walls and floors around the existing penetrants (cable trays, cables, metallic pipes, etc.). The liquid E473 is poured between pipes, conduits, cables trays and an outside steel sleeve, thereby completely encapsulating the existing seal. It expands slightly on curing, making a tight fit, so that in case of a fire, this external seal will prevent the passage of flames, smoke or toxic fumes through the penetrations.

* See "New Method of Using Flammadur E473 as an External Seal for Retrofitting with old Penetration Seals and for Openings with too Small Annular Spaces" FPT report, also can be seen on website: www.flammadur.com (go to Penetrations, then to E473, then to pipes, cables etc. under "external").

Tests of this new concept were conducted at Underwriters Laboratories, Inc, certified by UL, witnessed and also approved by Factory Mutual Insurance Corporation (FM Global Technologies), with resulting F=3 hours rating for all cables and pipes tested. For power/control cables inside of cable trays, results gave T=3 hours (see Table A), and for single copper conductor power cable in a cable tray, T=1 hour (see Table 2). For steel pipes and conduits, the tests results gave T=2 hours and for copper pipes T=1 hour (see Table C).

IV. Resistance of Flammadur[®] E473 to High Pressure Water

E473 was tested to simulate water pressure from floods, broken water pipes, tornados, etc. and withstood water pressure of 3 atm (45 psi) for 24 hours and 11 atm (15 psi) for 48 hours. For shorter times it passed hose stream tests at UL[®], for 30 psi (2 atm).

According to IEEE 643 (accepted by NRC), after an exposure in a standard furnace for 2 hours (required only 1 hour) E473 seal passed a hose stream test with pressure of 75 psi (4 atm) for 5 minutes, conducted in Omega Point Laboratories.

For higher water pressures such as may be associated with broken steam pipes within the containment area near the reactor, E473 can be covered with a 10 mm layer of

Flammadur[®] E292, a fire and water resistant polyurethane resin. This material is also resistant to gamma radiation. In water cooled reactors, the steam contains radioactive isotopes with radiation coming mostly from cesium-137 isotope. In the event of a broken steam pipe, tests on E292 verified that it was easily decontaminated after exposure to Cs-137.

E473 has high shearing strength to steel, and **steel sleeves** should be used whenever possible, particularly around cable trays and pipes, and also to protect fire seal from collapsing pieces of concrete inside walls or floors.

V. Fireproofing of Construction Joints

Concrete blocks with gaps between them must be sealed against passage of fire, smoke, fumes and water from fire hoses. **Flammadur[®] A107**, elastomeric fire retarding caulk has been tested and certified by Underwriters Laboratories in USA for 2 inch (50 mm) joint width with 3 hour ratings, for gaps in walls (system No. WWS-0026), floors (FFS0019), floor- to wall (curtain wall) FWS0002. Tests were witnessed and approved by Factory Mutual Insurance, Design No. 126 for gaps in floors. As an example, this system was installed recently in a nuclear power plant in Qinshan, China. A107 has been exposed to 200 million rads without any visible changes.

VI. Use of Flammadur[®] E473 for Providing Areas in the Fire Barrier for Future Cable, Cable Trays, Metallic Pipes, etc.

During construction, access can be provided for the future installation of additional cables, cables in a cable trays, and/or metallic pipes, etc., by using Flammadur[®] E473 in parts of the fire barriers. When needed, the E473 can be easily removed (drilled out) and the new penetrants can be inserted and any opening in the E473 can be filled to the original depth of the fire barrier with properly mixed E473. The initial installation of the E473 must be in accordance with the UL[®] certified systems for blank openings: C-AJ-0109 with ratings F=3 hours and T=1.5 hours, C-BJ-0029 with ratings F=4 hours, T= 4 hours, or a new system for a large opening with F=T=4 hours (in process). Systems for blank openings must

provide F and T ratings equal to or greater than the fire barrier in which it is installed. These systems, using E473, permit the inclusion of steel sleeves for structural strength.